



# The Complete Guide to Modular Data Center Solutions

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# Introduction

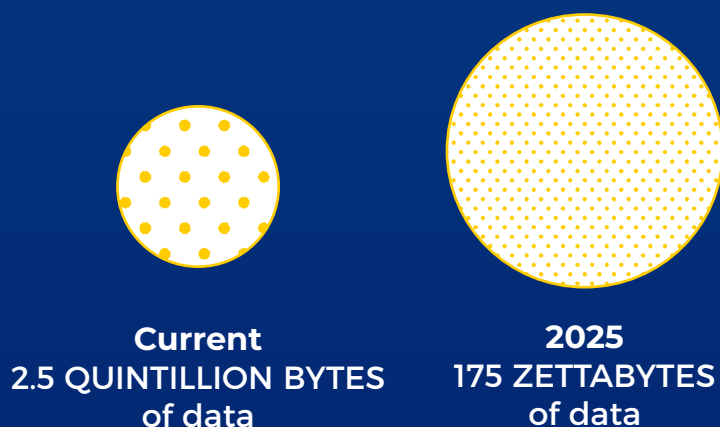
The world today runs on data—it is estimated that 2.5 quintillion bytes of data are created each day, and the International Data Corporation (IDC) predicts that worldwide data production will amount to 175 zettabytes by 2025.

As a result of the data deluge, corporations, colicators, cloud service providers and enterprise users are scrambling to quickly build new, more efficient data centers. This has drastically increased the number of data center expansion projects and hyperscale data center campuses being built across the country. In fact, there are now over 500 hyperscale data centers worldwide, up from 390 at the end of 2017.

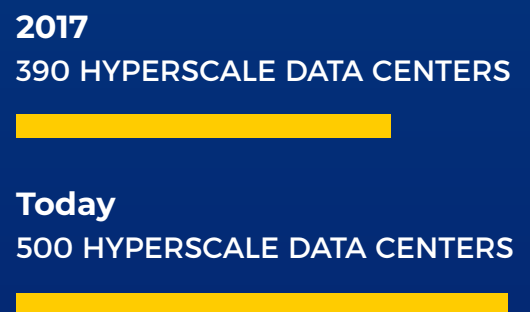
Despite this dramatic growth, many organizations are finding it harder and harder to complete their data center redesigns on time and on budget. In addition to the national skilled labor shortage, traditional construction methods introduce a slew of other operational challenges, such as budgeting constraints, construction delays, site waste and other roadblocks that extend the construction timeline. In order to scale quickly, manage costs and lay an extensible foundation that can evolve quickly with new technology, more data center owners are taking a modular approach to construction.

## The age of the modular data center is at hand.

### Worldwide Data Production



### Hyperscale Data Center Expansion Projects



# Increasing Data Center Demand

A variety of factors are driving demand for modular data centers. Here are just a few:

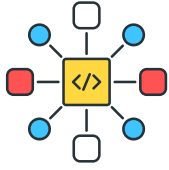


**Demand for more data analytics** – [Data-driven decision-making](#) is driving the need for further data and analysis. Data lakes are proliferating in the cloud to support big data analytics, but to reduce latency, computing power needs to be closer to home. Data centers are being upgraded to handle increased data storage and processing, which is creating scalability problems. For example, using more powerful servers generate more heat, which requires more power and cooling capacity. With a modular approach to data centers, scalability isn't a problem, because each module can be updated using the latest technologies, such as [direct liquid cooling](#). Modules can be optimized to handle the increased IT load and accommodate power and cooling, even as data processing capabilities scale. Modular data centers can also be used as standalone facilities or to expand existing data centers, which simplifies scalability to handle more data.

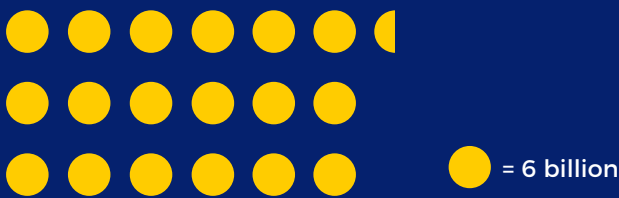


**More demand for colocation** – For organizations seeking greater control over their data processing without the need to build their own data center, colocation continues to be a popular option. By establishing a data center in someone else’s facility, organizations can increase security, cut costs and take advantage of services, such as [remote hands](#). Modular data centers also add value by expanding the capacity of the existing data center. For example, by using data center modules, you can quickly add customized capacity to a colocation built to tenant specifications, or you can move electrical equipment to an external module to free up data center white space. Therefore, adding modular systems makes for fast installation and scalability at relatively low cost.

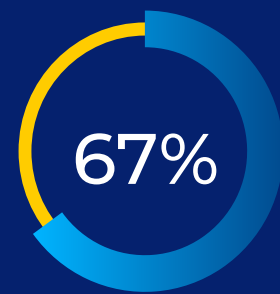
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**Edge computing** – With the increase in low-latency connections to handle high-demand, real-time applications — such as self-driving cars, augmented reality (AR) and virtual reality (VR) — edge computing is being deployed to handle data caching and reduce the cost of backhaul and broadband connections. Applications like the Internet of Things (IoT) are expected to add [75.44 billion connected devices](#) by 2025 that need real-time attention. Shipping this data to and from the cloud adds communications costs and latency. For example, [67 percent of manufacturing plants](#) are migrating to “smart factories,” which means an enormous increase in the amount of IoT traffic. Edge computing is a better approach to real-time data processing for IoT and similar applications, which creates more demand for modular data centers installed at the edge.



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**67 percent** of manufacturing plants are migrating to “smart factories.”



**Machine learning and AI** – Artificial intelligence (AI) is changing the data center infrastructure. In fact, Gartner predicts that [30 percent](#) of those data centers that fail to prepare for AI will become obsolete by the end of 2020. AI is being used for predictive analytics to manage data workloads, making data centers more efficient and easier to manage. Modular data centers provide a ready-made approach to upgrade or replace outmoded data centers to accommodate emerging technologies like AI. AI is even being used to [promote cooler data center operations](#) and cut energy costs, making modular data centers even more cost-effective.



**Cooler data centers** – Prior to the introduction of modular data center solutions, cooling was primarily the [biggest data center expense](#), accounting for 40-80 percent of total operating costs. As the demand for computing power continues to grow, the power density will increase. This will inevitably increase the demand for cooling in years to come. Although new techniques and technologies are helping to reduce data center cooling requirements, one of the easiest ways to reduce cooling costs is to increase efficiency or reduce the area that requires cooling. Modular data centers are less expensive to cool because they are both more efficient and more compact. They have greater energy efficiency because of matching components at the factory and because they can be configured to optimize cooling, including using hot and cold aisle containment as needed.

# Challenges That Are Changing Data Center Construction

Although demand for more brick-and-mortar data centers is on the rise, there are fewer resources available to actually construct new data centers.



**Aging Population** – The U.S. population is aging, which means there are fewer construction workers entering the workforce. The number of Americans that are 65 or older is expected to grow from 671.1 million in 2015 to about 1 billion in 2030, increasing from 9 to 12 percent of the U.S. population. This number is anticipated to rise even higher by 2060, accounting for 1.6 billion people or 17 percent of the total population. Despite the rapid growth of Americans aged 65 or older, the youth population (under the age of 20) is projected to have flat growth, and the working age population (aged 20 to 64) is projected to have moderate growth over the same period.



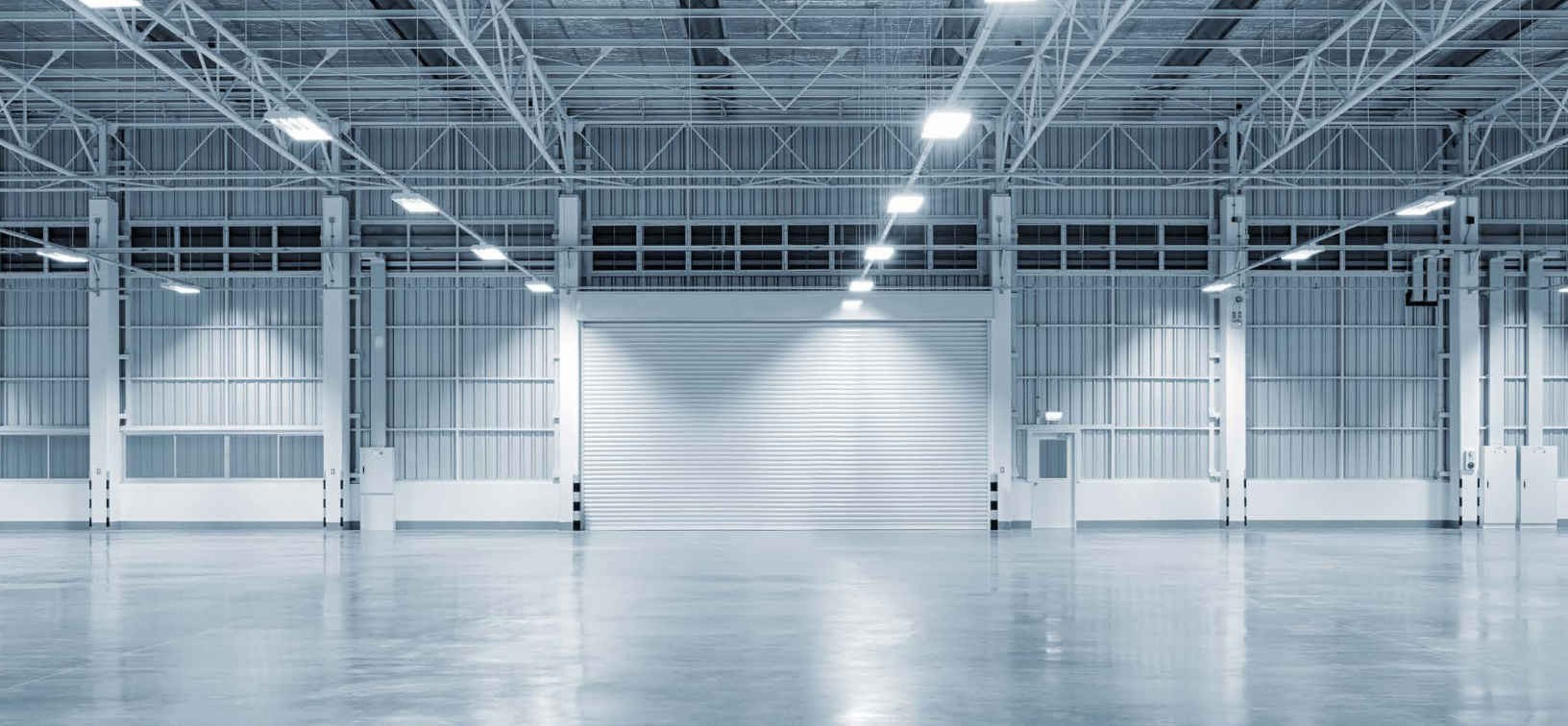




**National skilled labor shortage** – A national shortage in skilled labor is driving up construction costs and lengthening time to completion. The median age of construction workers today is [42.6 years old](#), meaning the current labor pool is aging out of the workforce. At the same time, [only 3 percent](#) of workers entering the workforce (aged 18 to 25) have expressed an interest in construction work, leading to the expectation that the labor shortage will continue into the foreseeable future. At the same time, data centers are expected to [double in capacity between 2015 and 2021](#). With skilled labor in short supply, modular data centers are gaining in popularity because they arrive ready to install.

In addition to a critical shortage in construction labor, those with the unique skills required for data center construction are even more scarce. Demand for hyperscale data centers and massive data center campuses, from [40,000 to 250,000 square feet](#), are paying top dollar and attracting the best available talent. In fact, most of the data centers being built are for giant tech companies, such as Apple, Google and Amazon. [Nine of the top 10](#) largest construction projects in 2018 were for fulfillment and data centers for Apple, Facebook, Amazon and Microsoft. Skilled data center workers are gravitating toward higher paying mega-contracts that take longer to complete, which means fewer skilled workers are available to build additional data centers.

With skilled labor in short supply, modular data centers are gaining in popularity because they arrive ready to install.



**Regulatory requirements** – Energy efficiency is taking on greater importance as data center developers seek to optimize power usage effectiveness (PUE). More data center designs are striving to achieve [LEED certifications](#) to prove energy efficiency, while servers and computing hardware are being made more resilient to heat, so they demand less cooling. Developers are continually wrestling to meet sustainability guidelines while making data centers more powerful than ever.

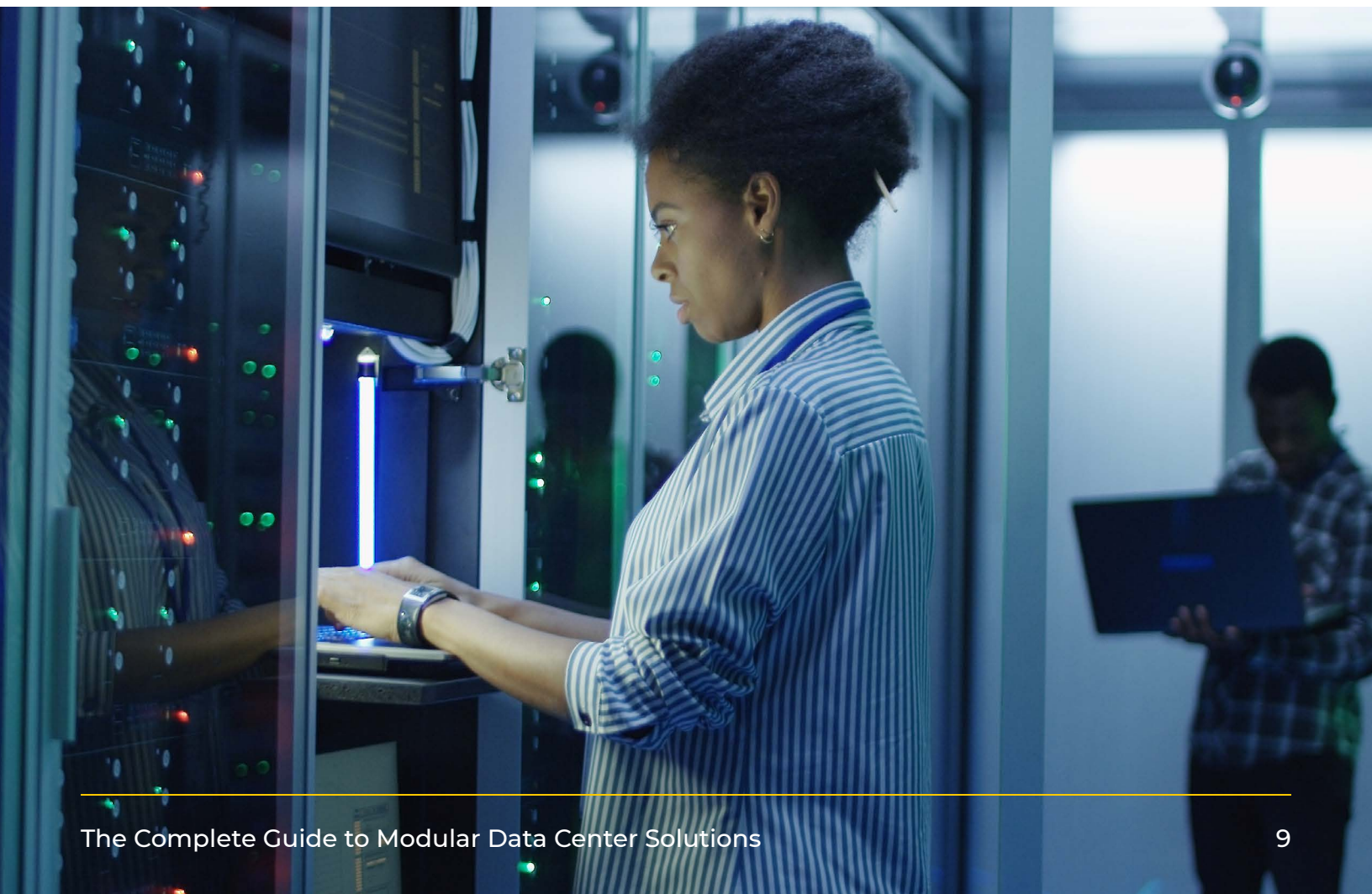


**Rising cost of real estate** – Data center real estate investment trusts (REITs) are competing for property to build new facilities to support cloud services and colocation providers. Northern Virginia, for example, has more than [100 data centers](#) and 50 million square feet of space. Northern Virginia in particular has become extremely dense with data center capacity because of its proximity to government agencies and its ability to accommodate mammoth cloud service providers like [Amazon Web Services \(AWS\)](#). Also, demand continues to be strong since there is only a 4.4 percent vacancy rate in the region as of 2018. In markets like these, the ability to add data center capacity, without incurring added real estate costs, makes modular data center construction extremely attractive.



**Increasing demand** – The increase in data center demand is promoting a race to revenue. Contractors are looking for ways to shorten time to completion, including reducing lead times for equipment. These include chillers, switchgear and uninterruptible power supply (UPS), as well as cutting construction time. With modular data centers, systems are shipped as completed units, ready to go. And modular data centers can typically be delivered in two-thirds the time it takes to build a new data center from the ground up.

These are just a few of the challenges for an industry seeking to expand data center capacity. Going modular doesn't mean having to settle for a cookie-cutter solution. Modular data centers are completely customizable and scalable, and can be developed with a variety of configurations.





# What is a “Modular” Data Center

Modular data centers can deliver all of the same benefits as brick-and-mortar data centers, but there are still many misconceptions about them, including design and installation.

Most people think modular data center solutions only encompass preconfigured equipment shipped in ISO shipping containers. These kinds of data centers are still found on oil rigs, military installations or government sites for agencies to deal with during disasters, because they are easy to assemble and transport. However, these are only one type of modular data center. Let’s break down what we mean by “modular” and the types of structures that are available.

There are three basic types of modular or portable data centers:

## THE ISO CONTAINER

These are factory-built data centers installed in a standard shipping container. They are generally installed outdoors on a concrete pad or foundation for permanent installation. They come in standard sizes so they have a predictable footprint—either 20 x 8 feet or 40 x 8 feet. They also have a standard height, and the only modifications are typically adding a door opening, installing power supplies and including chillers on the outside.

This type of modular data center usually has a practical limit on capacity of about 200 to 250kW for the IT space and 500kW for power and cooling. The size also limits the number of racks it can accommodate, but there are different configuration options to optimize rack space.

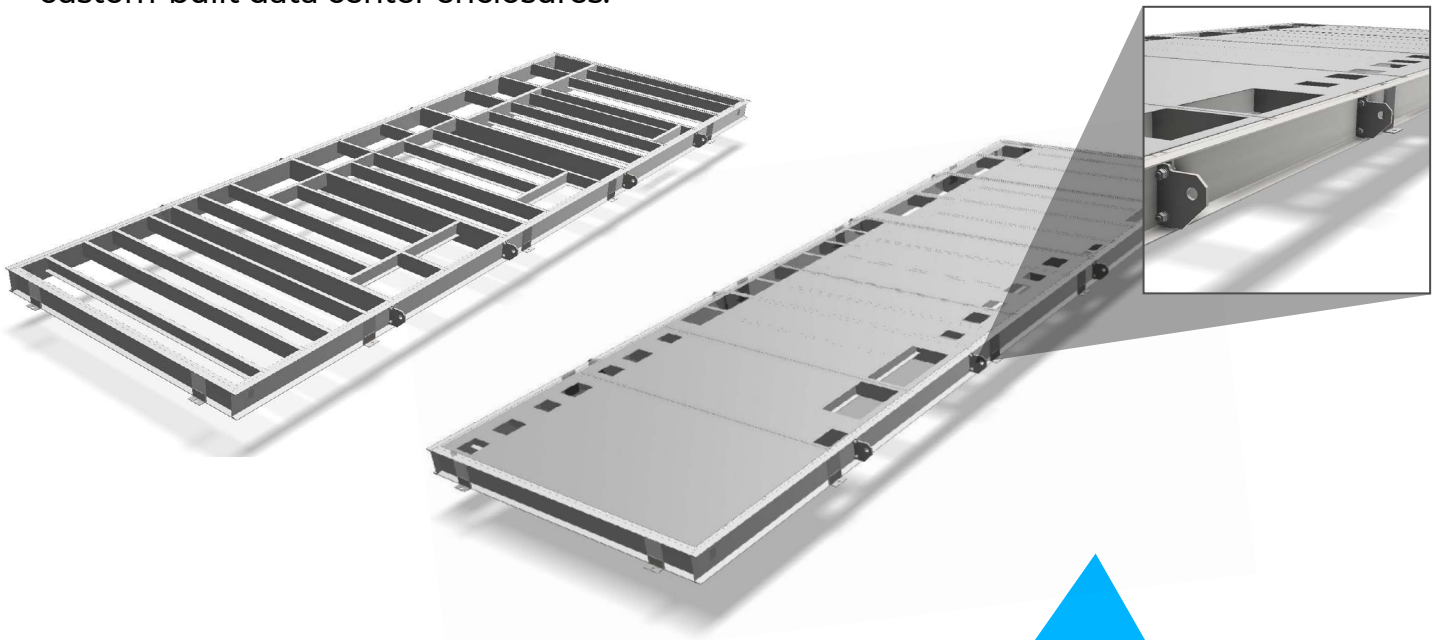
Once they have been modified, they will no longer meet ISO specifications unless they are built to proper standards and recertified. Failure to meet the ISO standard may present issues, such as the ability to stack containers. However, the size makes them easy to transport and drop in place.



## SKID-MOUNTED

Skid-mounted systems are permanently mounted on a metal platform and can be connected and integrated to all other equipment on that skid, as well as other electrical systems in the organization. These systems are easy to transport and install on-site. Commissioning pre-built skid systems simplifies construction because they can be used as pre-constructed building blocks for the data center. Skid-mounted modules are built and tested at the factory, and all adjustments are made prior to shipping. This is so the unit is delivered ready to install, which saves time by removing those critical steps from the on-site Path of Construction (POC).

In general, using modular data center skids offers more flexibility when expanding or building out a new data center, because they do not require the same space restrictions as enclosures. They can be custom-built and delivered for a shorter installation turnaround, and they typically [cost less and are more flexible](#) than custom-built data center enclosures.



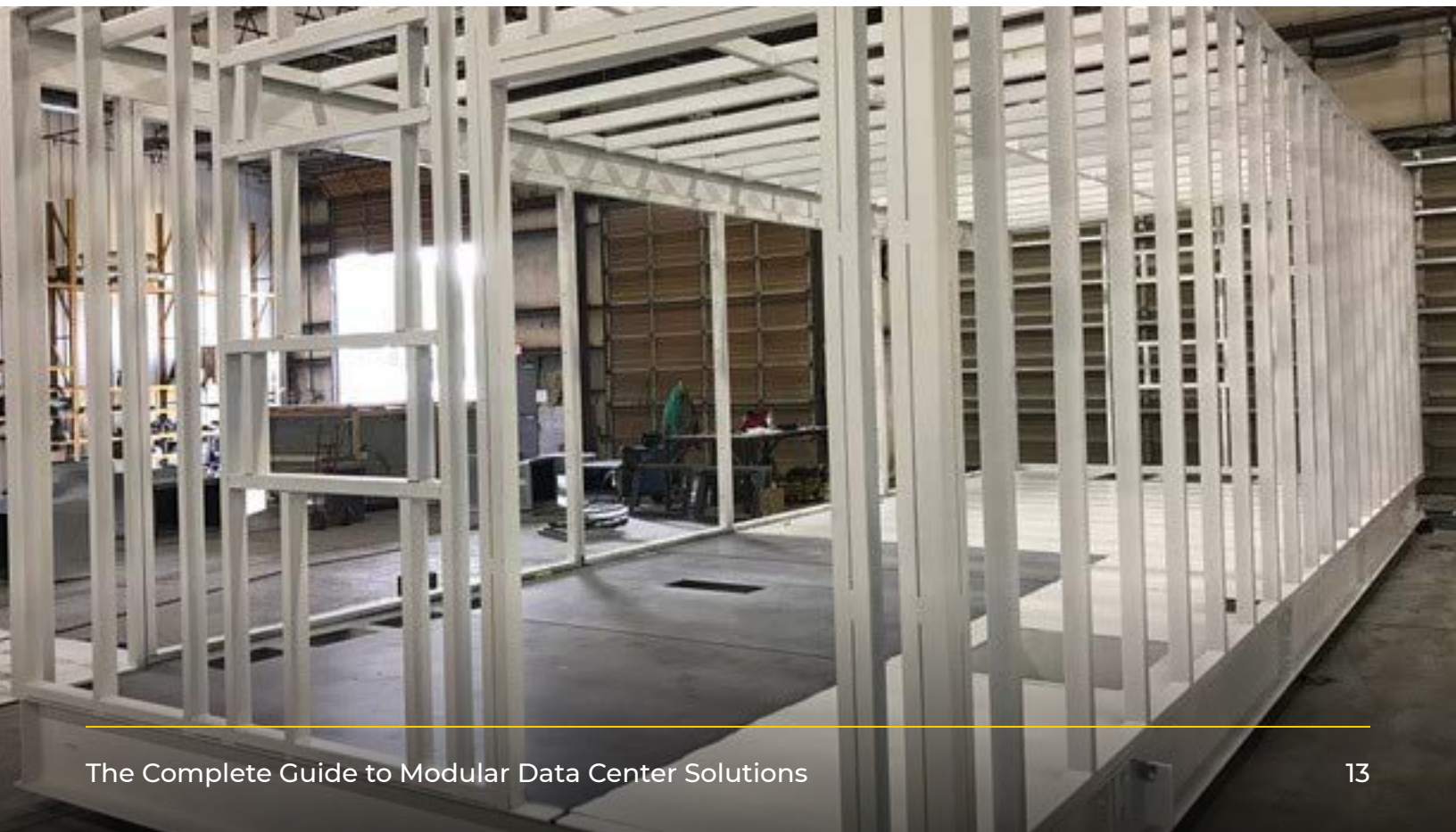
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## ENCLOSURE

Enclosures can come in various sizes and are self-contained shell or metal housings. They are delivered as pre-configured pieces that can be combined with additional modules on-site, which saves construction time and testing. They also are purpose-built to be installed inside an existing structure or outside, such as in a parking lot or adjacent to a building. In fact, one of the reasons to choose an enclosed modular data center is to protect the systems from the elements or harsh conditions, either outdoors or indoors.

Modular data center enclosures have two basic form factors: the all-in-one data center and an enclosure that separates the IT equipment from power and cooling infrastructure.

The all-in-one enclosure is more common and usually comes equipped with its own data center hardware, such as servers, storage and networking equipment. It also comes with its own power system and cooling, as well as dry-type fire suppression equipment, biometric locks or some other form of security, so that it is truly self-contained.



The second kind of enclosure splits the IT equipment, power and cooling into separate components. These custom enclosures have the same advantages as other modular designs; they are factory-built and tested, so they are more cost-effective and can be quickly commissioned. However, they offer the added benefit of flexibility, which makes it much easier to scale on demand. For example, if additional storage or servers are required, they can easily be added. Or, as equipment density increases, more power and cooling can be added as needed.

No matter what the form factor, today's modular data centers are factory-built and fully tested prior to delivery. They are typically configured for shipping and installation in three ways:

1. Fully prefabricated, which means the data center is fully composed of modular enclosures and tested in advance, including IT, power and cooling.
2. Semi-prefabricated, which means major data center components are built and tested off-site and then shipped to be integrated with other systems as part of a stick-built data center.
3. All-in-one, which is a data center that is completely self-contained and shipped ready for use. All that is required is to make the necessary network and power connections.





# Why Modular Data Centers Are the Solution

When weighing the pros and cons of using a modular approach to data centers, in lieu of a brick-and-mortar data center, modular data centers prove to have virtually all the capabilities of conventional data centers with more benefits. They also solve many of the construction challenges that go with erecting a stick-built data center.

Here is a list of the benefits of adopting a modular data center as opposed to a brick-and-mortar building:



**Shorter time to completion** – Time to completion is important because it represents time to revenue. Once the specifications for a new data center are set, it's a race to complete the finished structure in order to start profiting from data center operation. Most data centers take from 18 to 24 months to complete, but you can save an average of 30 percent in construction time by installing a modular data center. You can also eliminate construction delays due to inclement weather, equipment failure and other factors.



**Reduced costs** – Modular data centers also tend to be [30 percent less expensive](#) than stick-built data centers. Off-site factory assembly reduces construction costs and eliminates issues, such as weather delays and overruns in time or materials. In fact, when you buy a modular data center, you are essentially purchasing a piece of custom-built equipment. All the components and requirements are determined in advance, so the cost of assembly is fixed and you pay one price for delivery of the completed unit. The only cost variable could be final installation, although most modular data center providers include installation in their cost estimates. Having controlled costs is one of the most attractive aspects of going modular for many corporations.



**Easier to install** – Going modular means you can mitigate much of the need for skilled workers. Data center assembly is handled at the factory and ensured by proven methods, so you don't have to worry about pulling cable and integrating electrical and mechanical components on-site. All the assembly work at the factory is done according to predetermined specifications, and everything is fully tested prior to delivery. This means a complete plug-and-play data center is delivered ready for installation. It also creates a safe job site, as you eliminate the need to manually wire and assemble the unit.



**Compact design** – Real estate prices are at a premium, but a modular data center requires a very small footprint. If you opt for an outdoor installation, the data center can be set up in a parking lot or adjacent to a building, while requiring very little space. This not only provides added flexibility, but can also mean substantial savings, especially in high-rent markets like New York City or Chicago.



**Totally customizable** – Even though the components come ready to connect, the actual design is completely customizable. Depending on the form factor, you have various options in terms of rack placement, power capacity, cooling, etc. All the wiring, power, cooling and other operational specifications are determined prior to manufacture. System expansion is relatively easy because you can add more systems and capacity. And unlike stick-built data centers, you don't have to overbuild to accommodate future growth.



**Greater reliability** – Every component installed in a modular data center is thoroughly tested during manufacture and assembly. This means there is less likelihood of failure.



**Lower PUE** – Power usage effectiveness (PUE) is substantially lower than brick-and-mortar data centers because of the modular unit's compact size and the fact that all of the components are exactly matched.



**Easy to secure** – Since a modular data center is more compact and self-contained, it is easier to secure, especially if you can install it behind a secure barrier with video monitoring.

In short, modular data centers are suitable for any application in which a conventional data center is used. As demand increases for more data center versatility with the advent of private and hybrid cloud computing and edge computing, modular data centers will continue to prove to be a cost-effective approach that has lasting benefits.



# The Cost Advantages of a Modular Data Center

We already noted that modular data centers are about 30 percent less expensive than stick-built data centers. The savings aren't solely from the fixed data center costs and in installation overhead. There are a variety of additional factors that make the total cost of ownership (TCO) of modular data centers substantially lower than traditional brick-and-mortar structures.



## **CAPITAL EXPENDITURES**

When you use a preconfigured, standardized data center architecture, you reduce capital expenditure (capex). Components that are assembled off-site by a single vendor reduce capex. Factory assembly and testing by a single source is also less expensive than assembling parts from different sources at the construction site.

Modular data centers also have an application-specific design that makes them better suited to their environment and application, which can mean additional cost savings. For example, installing a modular data center at a hospital may mean it doesn't fall under the more stringent hospital construction code requirements.

Using a prefabricated construction approach sets the design in advance, which eliminates change orders. It also results in a "right-sized" data center so there isn't any added cost for planned overcapacity. With stick-built data centers, the design has to accommodate the worst-case final load scenario, so all the capacity has to be planned in at the outset, which means you are paying for more capacity than you may need. If you have the flexibility to scale the data center to the right size at the outset, you aren't paying for unused cooling and power capacity. With modular data centers, you can scale over time as needed, which reduces initial capital outlays.

Under certain circumstances, tax depreciation for modular data centers may be faster as well. Consult a tax expert to determine how large the tax savings could be.

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## OPERATING EXPENDITURES

Modular data centers also minimize operating expenses (opex). For example, you have less stranded capacity, i.e., the data center is custom-built, so there is less unused space that has to be supported by cooling and power. Because modular means flexible and scalable, you are only supporting what you need, so the data center is operating at maximum capacity with less stranded capacity.

Proper capacity planning also means greater energy efficiency and lower PUE. PUE is the ratio of how much energy is consumed by the computing hardware in contrast to the power needed for the entire facility. For example, a PUE of 1.0 would be 100 percent efficiency (which is not achievable). A ratio of 1.3 would mean 30 percent of the total power is used for the infrastructure to support the IT equipment. Because modular data centers have additional space, power and cooling are added to increase computing capacity as needed, and the PUE will always be lower by design.

With designs that are scalable and versatile, modular data centers can easily accommodate newer, more advanced equipment. As computing capacity becomes denser, equipment will become more energy efficient, which will mean lower opex.

To maximize both capex and opex, you need to work with a modular data center expert, who can provide design options and construct a facility to meet your unique requirements.



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# What to Look for in a Modular Data Center Provider

When shopping for a vendor to supply your modular data center, you want to look for professionals with experience and a proven track record.

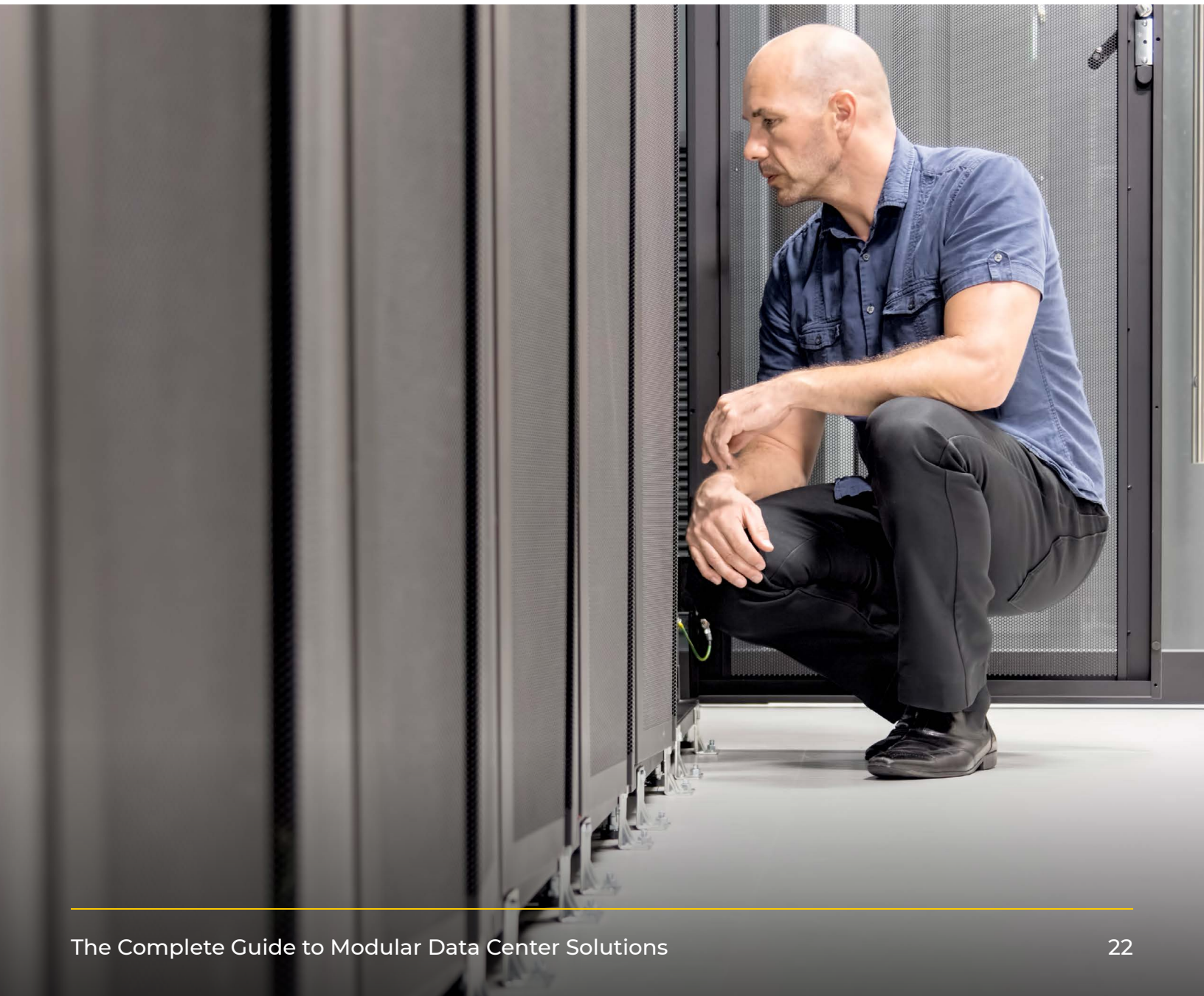
Be sure to ask about their past experience in designing and installing modular data centers. What types of data centers have they delivered in the past and for what types of applications? Be sure to ask for customer examples and references.

Are they experienced in working in a controlled and regulated construction environment? For example, are their projects built in compliance with the [National Electric Code \(NEC\)](#) and [Underwriter Laboratories \(UL\)](#) certifications? What is their history working with local building authorities? What about their safety record? What industry certifications do they have, such as [ISO 9001:2015](#)?



What about their construction and vendor selection process? For example, do they keep their inventory in stock or order as needed? Can they work with multiple vendors, or do they only specify certain products and brands? How versatile are they when it comes to customized designs?

Be sure to ask about installation and service warranties. When you buy a modular data center, you are essentially purchasing custom-designed equipment. That equipment should be warrantied against failure. You also should inquire about extended warranties and upgrading the system to protect your investment for the future.





# Myths About Modular Data Centers

There are still a number of misconceptions about modular data centers and their applications. Here are six of the most common myths that should be debunked:

## **MYTH 1: Modular data centers come in ISO shipping containers.**

Once upon a time, portable data centers were solely shipped in shipping containers. Today, modular data centers are available in various configurations to suit any installation or need, whether it's a single rack, a room or a larger facility. Modular data centers are shipped to their destination and assembled on-site in any form factor that is required.

## **MYTH 2: Modular data centers are only used for temporary installations.**

In fact, modular data centers have a prefabricated design that should last for years. They are designed for permanent installation, either inside an existing data center or adjacent to another building.

## **MYTH 3: Modular data centers tend to be more expensive.**

Because they are designed and assembled at the factory, they require fewer personnel and resources to construct, so modular data centers are less expensive to build than building data centers on-site. In fact, they tend to be about 30 percent less expensive. They come preassembled, making them less expensive to install; and they are less expensive to operate because all of the components are optimized to work together.

Modular data centers tend to be about 30 percent less expensive

#### **MYTH 4: Modular data centers are less secure.**

Modular data centers are self-contained and easier to secure, especially if they are installed in a secured area with guards, closed-circuit television (CCTV) security cameras and fences.

#### **MYTH 5: You have limited hardware and design choices with prefabricated data centers.**

Modular data centers are fully customizable and can be designed using designated hardware or configured to install your own equipment. In fact, modular data centers are designed to accommodate any computing need, and you still have the benefit of factory assembly and testing.

#### **MYTH 6: Modular data centers are fixed and won't scale.**

One of the advantages of modular data centers is that they are extensible and new components can be added at any time. Unlike brick-and-mortar data centers that can be difficult to scale without operational risks, modular data center components are built and tested before they are installed, so new capacity is essentially plug and play.

When you consider all the capabilities of today's modular data center, they prove to be a viable alternative to the conventional brick-and-mortar data centers. Going modular saves time and money, lowers PUE and provides lasting value. In fact, because of their scalability, small footprint and bandwidth capacity, the U.S. all-in-one modular data center market is expected to reach \$4.6 billion by 2027.

#### **The future of data center design and construction is upon us—are you ready?**

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